

**CLAIMS**

1. A method for the continuous cooking of wood raw material for the production of cellulose pulp, where the wood raw material and the cooking fluid are fed to the top of a continuous digester and where a cooking temperature of 130-170° is established in the cooking vessel while the wood raw material experiences a retention time of at least 90 minutes at this cooking temperature, and where the wood raw material sinks continuously through the digester from the top down to its bottom in order to be finally expelled from the bottom of the digester, and at least two withdrawal positions for cooking fluid are arranged in the digester at different heights, at least one first lower and one second upper withdrawal position in the digester, where the cooking fluid at the first and the second withdrawal position is withdrawn after the wood raw material has had a retention time in the digester that differs by at least 10 minutes, and preferably by at least 20 minutes, and where a zone of countercurrent flow or of concurrent flow is established in the digester between the withdrawal positions

characterised in that

the differential pressure ( $\Delta P$ ) between the upper and the lower withdrawal positions is determined ( $\Delta P = P_{\text{upper}} - P_{\text{lower}}$ )

and when a cooking zone of concurrent flow has been established between the withdrawal positions and when the differential pressure ( $\Delta P$ ) exceeds a pre-determined level, a connection between these withdrawal positions opens,

and when a cooking zone of countercurrent flow has been established between the withdrawal positions and when the differential pressure ( $\Delta P$ ) falls below a pre-determined level, a connection between these withdrawal positions opens.

2. The method according to claim 1 where the first withdrawal position is constituted by a withdrawal strainer that is located at the bottom of the digester in the wall section of the digester, and where the second

withdrawal position is constituted by a withdrawal strainer that is located above the first withdrawal strainer at a distance that ensures that the wood raw material has had a retention time that is at least 10 minutes, preferably at least 20 minutes, shorter in the digester and where the physical distance  
5 between the strainers is at least 2 metres, and preferably at least 5 metres, and where the digester has a third withdrawal position above the second withdrawal position where cooking fluid at the third withdrawal position is withdrawn after the wood raw material has had a retention time in the digester that is shorter and differs relative to the second withdrawal  
10 position by at least 10 minutes, and preferably by at least 20 minutes, and where a zone of concurrent flow or countercurrent flow is established in the digester between the second and the third withdrawal positions characterised in that

the differential pressure ( $\Delta P$ ) between the second and the third  
15 withdrawal positions is determined

and when a cooking zone of concurrent flow has been established between the second and the third withdrawal positions and when the differential pressure ( $\Delta P$ ) exceeds a pre-determined level, a connection between the second and the third withdrawal positions opens,  
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and when a cooking zone of countercurrent flow has been established between the second and the third withdrawal positions and when the differential pressure ( $\Delta P$ ) falls below a pre-determined level, a connection between the second and the third withdrawal positions opens.

25 3. The method according to claim 2 where the digester has a fourth withdrawal position where the cooking fluid at this fourth withdrawal position is withdrawn after the wood raw material has had a retention time in the digester that differs relative to that at the third withdrawal position by at least 10 minutes, and preferably by at least 20 minutes, and where a  
30 zone of countercurrent flow of concurrent flow is established in the digester between the third and the fourth withdrawal positions characterised in that

the differential pressure ( $\Delta P$ ) between the third and the fourth

withdrawal positions is determined

and when a cooking zone of concurrent flow has been established between the third and the fourth withdrawal positions and when the differential pressure ( $\Delta P$ ) exceeds a pre-determined level, a connection  
5 between the third and the fourth withdrawal positions opens,

and when a cooking zone of countercurrent flow has been established between the third and the fourth withdrawal positions and when the differential pressure ( $\Delta P$ ) falls below a third pre-determined level, a connection between the third and the fourth withdrawal positions opens.

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4. The method according to claim 3 where the digester has a fifth withdrawal position where the cooking fluid at this fifth withdrawal position is withdrawn after the wood raw material has had a retention time in the digester that differs relative to that at the fourth withdrawal position by at  
15 least 10 minutes, and preferably at least 20 minutes, and where a cooking zone of countercurrent flow or concurrent flow is established in the digester between the fourth and fifth withdrawal positions  
c h a r a c t e r i s e d in that

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the differential pressure between the fourth and the fifth withdrawal  
20 positions is determined

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and when a cooking zone of concurrent flow has been established between the fourth and the fifth withdrawal positions and when the differential pressure ( $\Delta P$ ) exceeds a pre-determined fourth level, a connection between the fourth and the fifth withdrawal positions opens,

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and when a cooking zone of countercurrent flow has been established between the fourth and the fifth withdrawal positions and when the differential pressure ( $\Delta P$ ) falls below a fourth pre-determined level, a connection between the fourth and the fifth withdrawal positions opens.

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5. The method according to any one of the preceding claims  
c h a r a c t e r i s e d in that the connection opens such that the flow in the connection between adjacent withdrawal positions becomes parallel to a

flow of cooking fluid established in the digester through the column of chips between the relevant withdrawal strainers.

6. The method according to any one of the preceding claims in which  
5 washing fluid is added at the bottom of the digester through a pressurised washing fluid line, c h a r a c t e r i s e d in that the differential pressure between the washing fluid line and the withdrawal position that is arranged at the bottom of the digester is determined, and when this differential pressure exceeds a pre-determined sixth level, a connection opens  
10 between the washing fluid line and this withdrawal position.
7. The method according to any one of the preceding claims in which wood raw material and cooking fluid are added at the top of the digester during the withdrawal of cooking fluid at the top of the digester in a top strainer in  
15 direct connection with the top of the digester, and where the top strainer withdraws cooking fluid from the wood raw material before this wood raw material has experienced any significant retention time in the digester, for return to the input system of the digester through a return line c h a r a c t e r i s e d in that the differential pressure between the return  
20 line and the withdrawal position that is arranged at the top of the digester, while remaining below the top strainer, is determined, and when this differential pressure exceeds a pre-determined seventh level, a connection between the return line and this withdrawal position opens.
- 25 8. The method according to any one of the preceding claims c h a r a c t e r i s e d in that the differential pressures between all withdrawal positions from the bottom of the digester up to the uppermost withdrawal position at which cooking fluid is withdrawn in order to be led away to the recovery process, possibly via its use in black liquor  
30 impregnation, are determined and when the differential pressure between any of these adjacent positions exceeds pre-determined levels when a cooking zone of concurrent flow has been established between the withdrawal positions or falls below pre-determined levels when a cooking zone of countercurrent flow has been established between the withdrawal

positions, connections are opened between the relevant adjacent withdrawal positions.

9. The method according to any one of the preceding claims

characterised in that the differential pressures between all withdrawal positions in the complete digester at which cooking fluid is withdrawn are determined and when the differential pressure between any of these adjacent positions exceeds pre-determined levels, connections are opened between the relevant adjacent withdrawal positions.

10. The method according to any one of the preceding claims

characterised in that the withdrawal position may be a cooking flow in which cooking fluid is withdrawn and conditioned in an external treatment before being returned to the digester at the same level as the relevant withdrawal position, where the conditioning of the cooking fluid involves at least one of: heating; addition of cooking chemicals, preferably alkali; and withdrawal of consumed cooking fluid from the digester to a recovery process, possibly via the use of the consumed cooking fluid in a pre-impregnation stage.

11. A continuous digester for the cooking of wood raw material for the

production of cellulose pulp, where the wood raw material and the cooking fluid are fed in ( $C_{IN}$ ) at the top of a continuous digester and where a cooking temperature of 130-170° is established in the cooking vessel while the wood raw material obtains a retention time of at least 90 minutes at this cooking temperature, and where the wood raw material sinks continuously through the digester from the top down to its bottom in order to be finally output ( $C_{OUT}$ ) from the bottom of the digester, and at least two withdrawal positions (11A-11E) for cooking fluid are arranged in the digester at different heights, in the form of a lower and a second upper withdrawal position in the digester, where the cooking fluid at these withdrawal positions is withdrawn from the digester through a strainer arranged in the wall of the digester and onwards via a withdrawal line

(12A-12E), where the cooking fluid in the first and the second withdrawal positions is withdrawn after the wood raw material has had a retention time in the digester that differs by at least 10 minutes, and preferably by at least 20 minutes, and where a zone of countercurrent flow or of concurrent flow is established in the digester between the first and second withdrawal positions c h a r a c t e r i s e d in that a regulator valve (18A-18E) is arranged in a shunt line (17A-17E) between the withdrawal line at the first and second withdrawal positions, which regulator valve is controlled by a differential pressure gauge (PC) that is arranged to determine not only the pressure in the withdrawal line at the first lower withdrawal position, but also the pressure in the withdrawal line at the second upper withdrawal position and determine a difference in pressure between the upper and the lower withdrawal position and that, depending on an established cooking zone of concurrent flow between the upper and the lower withdrawal position and the exceeding of a pre-determined threshold value for the differential pressure, opens the regulator valve, or on the establishment of a cooking zone of countercurrent flow between the upper and the lower withdrawal position and the pressure falling below a pre-determined threshold value of the differential pressure opens the regulator valve.

12. The continuous digester according to claim 11 where the first withdrawal position is constituted by a withdrawal strainer (11E) that is located at the bottom of the digester in the wall section of the digester, and where the second withdrawal position is constituted by a withdrawal strainer (11D) that is located above the first withdrawal strainer at a distance that ensures that the wood raw material has had a retention time that is at least 10 minutes, preferably at least 20 minutes, shorter in the digester, and where the physical distance between the strainers is at least 2 metres, and preferably at least 5 metres, and where the digester has a third withdrawal position (11C) above the second withdrawal position where cooking fluid at the third withdrawal position is withdrawn after the wood raw material has had a retention time in the digester that is shorter and differs relative to the second withdrawal position by at least 10 minutes, and preferably by at least 20 minutes, and where a cooking zone of concurrent flow or

countercurrent flow is established in the digester between the second and the third withdrawal positions c h a r a c t e r i s e d in that a regulator valve (18D) is arranged in a shunt line (17D) between the withdrawal lines (12D and 12C) of the second and third withdrawal positions, which regulator  
5 valve is controlled by a differential pressure gauge (PC) that is arranged to determine not only the pressure in the withdrawal line (12C) at the second withdrawal position, but also the pressure in the withdrawal line (12D) at the third withdrawal position and determine a difference in pressure between the third and the second withdrawal positions

10 and that, depending on an established cooking zone of concurrent flow between the third and the second withdrawal positions and the exceeding of a pre-determined threshold value for the differential pressure, opens the regulator valve (18D), or on the establishment of a cooking zone of countercurrent flow between the third and the second withdrawal position  
15 and the pressure falling below a pre-determined threshold value of the differential pressure opens the regulator valve.

13. The continuous digester according to claim 12 where the digester has a fourth withdrawal position (11B) where the cooking fluid is drawn off at this  
20 fourth withdrawal position after the wood raw material has had a retention time in the digester that is at least 10 minutes, preferably at least 20 minutes, shorter relative to that of the third withdrawal position, and where a cooking zone of countercurrent flow or concurrent flow is established in the digester between the third and the fourth withdrawal positions  
25 c h a r a c t e r i s e d in that a regulator valve (18C) is arranged in a shunt line (17C) between the withdrawal lines (12C and 12D) of the third and fourth withdrawal positions, which regulator valve is controlled by a differential pressure gauge (PC) that is arranged to determine not only the pressure in the withdrawal line (12D) at the third withdrawal position, but  
30 also the pressure in the withdrawal line (12C) at the fourth withdrawal position and, depending on the exceeding of a pre-determined threshold value for the differential pressure, opens the regulator valve (18C).

14. The continuous digester according to claim 13 where the digester has a fifth withdrawal position (11A) where the cooking fluid is drawn off at this fifth withdrawal position after the wood raw material has had a retention time in the digester that differs by at least 10 minutes, preferably at least 20 minutes, relative to that at the fourth withdrawal position, and where a cooking zone of countercurrent flow or concurrent flow is established in the digester between the fourth and the fifth withdrawal positions characterised in that a regulator valve (18B) is arranged in a shunt line (17B) between the withdrawal lines (12B and 12A) of the fourth and fifth withdrawal positions, which regulator valve is controlled by a differential pressure gauge (PC) that is arranged to determine not only the pressure in the withdrawal line (12B) of the fourth withdrawal position, but also the pressure in the withdrawal line (12A) of the fifth withdrawal position and, depending on the exceeding of a pre-determined threshold value for the differential pressure, opens the regulator valve (18B)
15. The continuous digester according to any one of the preceding claims 11-14 in which washing fluid is added at the bottom of the digester through pressurised nozzles (6A-6C) via a pressurised washing fluid line (WL/6), characterised in that a regulator valve (18F) is arranged in a shunt line (17F) between the withdrawal line (12E) for the withdrawal position at the bottom of the digester and the washing fluid line (WL/6), which regulator valve is controlled by a differential pressure gauge (PC) arranged to determine not only the pressure in the washing fluid line (WL/6) but also the pressure in the withdrawal line (12E) for the withdrawal position at the bottom of the digester and, depending on the exceeding of a pre-determined threshold value for the differential pressure, to open the regulator valve (18F).
16. The continuous digester according to any one of the preceding claims 11-15 in which wood raw material and cooking fluid are added (C<sub>IN</sub>) at the top of the digester during the withdrawal of cooking fluid at the top of the digester in a top strainer (4) in direct connection with the top of the digester and where the top strainer (4) withdraws cooking fluid from the wood raw



material before this wood raw material has experienced any significant retention time in the digester, for return to the input system (1) of the digester through a return line (3), c h a r a c t e r i s e d in that a regulator valve (18A) is arranged in a shunt line (17A) between the return line (3) and the withdrawal line (12A) at the withdrawal position (11A) that is arranged at the top of the digester, while remaining below the top strainer (4), which regulator valve is controlled by a differential pressure gauge (PC) that is arranged to determine not only the pressure in the return line (3) but also the pressure in the withdrawal line (12A) at the withdrawal position (11A) that is arranged at the top of the digester, while remaining below the top strainer (4), and, depending of the exceeding of a pre-determined threshold of the differential pressure level, opens the regulator valve (18A).

17. The continuous digester according to any one of the preceding claims 11-16, c h a r a c t e r i s e d in that regulator valves (18D, 18E) are arranged in shunt lines (17D, 17E) connected between all adjacent withdrawal positions (11C, 11E) from the bottom of the digester up to the uppermost withdrawal position (11C) at which cooking fluid is withdrawn in order to be led away to the recovery process (REC), possibly via the use of the withdrawn cooking fluid in black liquor impregnation, where each one of these regulator valves is controlled by a differential pressure gauge that determines the pressure in the relevant withdrawal line at the adjacent withdrawal position and that, depending on either the exceeding of a pre-determined level for the differential pressure when a cooking zone of concurrent flow has been established between the withdrawal positions or the falling below a pre-determined level of the differential pressure when a cooking zone of countercurrent flow has been established between the withdrawal positions, opens the relevant regulator valve.

18. The continuous digester according to any one of the preceding claims 11-17, c h a r a c t e r i s e d in that a shunt line (17B-17E) is located between each withdrawal position (11A-11E) throughout the digester between the withdrawal line (12A-12E) of each adjacent withdrawal position, and that a

regulator valve (18B -18E) is located in each shunt line, controlled by a differential pressure gauge (PC) that determines the pressure in the relevant withdrawal line at the adjacent withdrawal position and that, depending on either the exceeding or the falling below of a pre-determined threshold level for the differential pressure, opens the relevant regulator valve.

19. The continuous digester according to any one of the preceding claims 11-18, characterised in that the withdrawal position may be a cooking flow in which cooking fluid is withdrawn through a cooking strainer arranged in the wall of the digester, and conditioned in an external treatment before its return to the digester via central pipes (13A, 13B, 13E) at the same level as the relevant withdrawal position (11A, 11B and 11E), where the conditioning of the cooking fluid involves at least one of: heating (16A, 16B, 16E); addition of cooking chemicals (ADD), preferably alkali; and withdrawal (REC) of consumed cooking fluid from the digester to a recovery process, possibly via the use of the consumed cooking fluid in a pre-impregnation stage of the wood raw material.

20. The continuous digester according to claim 19, characterised in that the shunt line is arranged connected between the adjacent withdrawal line and, when viewed from the point of view of the direction of flow of the cooking flow, before a circulatory pump (15A-15E) arranged in the relevant cooking flow.